



*AGreen Engineering - the environmentally conscious
design and commercialization of processes and
products®*

Textbook Outline

Part I: A Chemical Engineer's Guide to Environmental Issues and Regulations: This section provides an overview of major environmental issues, and an introduction to environmental legislation, risk management and risk assessment.

1. An Introduction to Environmental Issues

- The Role of Chemical Process and Chemical Products
- An Overview of Major Environmental Issues
- Global Environmental Issues
- Air Quality Issues
- Water Quality Issues
- Ecology
- Natural Resources
- Waste Flows in the United States

2. Risk Concepts

- Description of Risk
- Value of Risk Assessment in the Engineering Profession
- Risk-Based Environmental Law
- General Overview of Risk Assessment Concepts
- Hazard Assessment
- Dose-Response
- Exposure Assessment
- Risk Characterization

3. Environmental Law and Regulations: from End-of-Pipe to Pollution Prevention

- Nine Prominent Federal Environmental Statutes
- Evolution of Regulatory and Voluntary Programs: from End-of-Pipe to Pollution Prevention
- Pollution Prevention Concepts and Terminology

4. The Roles and Responsibilities of Chemical Engineers

- Responsibilities for Chemical Process Safety
- Responsibilities for Environmental Protection
- Further Reading in Green Engineering Ethics

Part II: Evaluating and Improving Environmental Performance of Chemical Process Designs: This section will describe a variety of analysis tools for assessing and improving the environmental performance of chemical processes. The group of chapters will begin at the molecular level, and then proceed to an analysis of process flowsheets.

5. Evaluating Environmental Fate: Approaches based on Chemical Structure

- Chemical & Physical Property Estimation
- Estimating Environmental Persistence
- Estimating Ecosystem Risks
- Using Property Estimates to Estimate Environmental Fate and Exposure
- Classifying Environmental Risks Based on Chemical Structure

6. Evaluating Exposures

- Occupational Exposures: Recognition, Evaluation, and Control
- Exposure Assessment for Chemicals in the Ambient Environment
- Designing Safer Chemicals

7. Green Chemistry

- Green Chemistry Methodologies
- Quantitative/Optimization Based Frameworks for the Design of Green Chemical Synthesis Pathways
- Green Chemistry Expert System Case Studies

8. Evaluating Environmental Performance During Process Synthesis

- Tier 1 Environmental Performance Tools
- Tier 2 Environmental Performance Tools
- Tier 3 Environmental Performance Tools

9. Unit Operations and Pollution Prevention

- Pollution Prevention in Material Selection for Unit Operations
- Pollution Prevention for Chemical Reactors
- Pollution Prevention for Separation Devices
- Pollution Prevention Applications Separative Reactors
- Pollution Prevention in Storage Tanks and Fugitive Sources
- Pollution Prevention Assessment Integrated with HAZ-OP Analysis
- Integrating Risk Assessment with Process Design—a Case Study

10. Flowsheet Analysis for Pollution Prevention

- Process Energy Integration
- Process Mass Integration
- Case Study of a Process Flowsheet

11. Evaluating the Environmental Performance of a Flowsheet

- Estimation of Environmental Fates of Emissions and Wastes
- Tier 3 Metrics for Environmental Risk Evaluation of Process Designs

12. Environmental Cost Accounting

- Definitions
- Magnitudes of Environmental Costs
- A Framework for Evaluating Environmental Costs
- Hidden Environmental Costs
- Liability Costs
- Internal Intangible Costs
- External Intangible Costs

PART III: Moving Beyond the Plant Boundary: This section will describe tools for improving product stewardship and improving the level of integration between chemical processes and other material processing operations.

13. Life Concepts, Product Stewardship and Green Engineering

- Introduction to Product Life Cycle Concepts
- Life Cycle Assessments
- Streamlined Life Cycle Assessments
- Uses of Life Cycle Studies

14. Industrial Ecology

- Material Flows in Chemical Manufacturing
- Eco-Industrial Parks
- Assessing Opportunities for Waste Exchanges and Byproduct Synergies

Series of Appendices:

Appendix A - Details of the Nine Prominent Federal Environmental Statutes

Appendix B - Molecular Connectivity

Appendix C - Estimating Emissions from Storage Tanks

Appendix D - Tables of Environmental Impact Potentials - Tables D1 – D4

Appendix E - Procedures for Estimating Hidden (Tier II) Costs - Tables E1 - E5

Appendix F - Additional Resources - Web Resources/Online Databases/Software